Center Independent Research & Development: GSFC IRAD

Parametric Amplifiers for Readout of Low-Temperature Detectors

Completed Technology Project (2014 - 2015)

Project Introduction

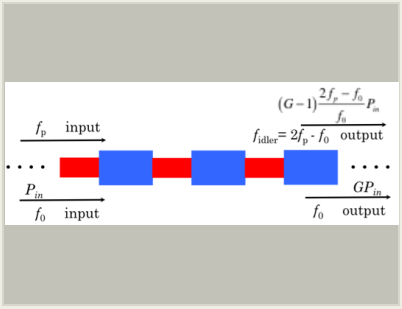
This project aims to make microwave parametric amplifiers with high gain, large bandwidth, ultra-low noise, and low power dissipation. Our amplifiers are designed to have greatly improved gain characteristics over similar experimental devices. The amplifiers would enable revolutionary astrophysics instruments with far-infrared photon-counting detectors or high-resolution x-ray microcalorimeters.

Our goal is to build microwave amplifiers with near quantum-limited sensitivity, octave or greater bandwidth, gain > 20 dB for signals of frequency 1 – 10 GHz, and power dissipation less than 1 microwatt at a 100 mK operating temperature, or 1 milliwatt at 4 K. Such amplifiers would find immediate application in efforts to develop far infrared instruments based on Microwave Kinetic Inductance Detectors (MKIDs), or in x-ray microcalorimeters with microwave SQUID amplifier (mSQUID) readout systems.

Existing state-of-the-art broadband HEMT amplifiers used so far for MKID or mSQUID readout have noise temperatures about 1 – 10 K. The noise of HEMTs, while low enough for many applications, limits sensitivity of MKIDs. In addition, the power dissipation of cryogenic HEMTs is not as low as desired in a space-based instrument. The new amplifiers in this project would be of great benefit in high performance instrument concepts involving MKID or mSQUID arrays for astrophysics missions.

Anticipated Benefits

Applicable in ground-based demonstration instruments for astrophysics. Provide lower amplifier noise temperature and lower power dissipation than state-of-the art High Electron Mobility Transistors over a wide bandwidth.



Parametric Amplifier Sketch

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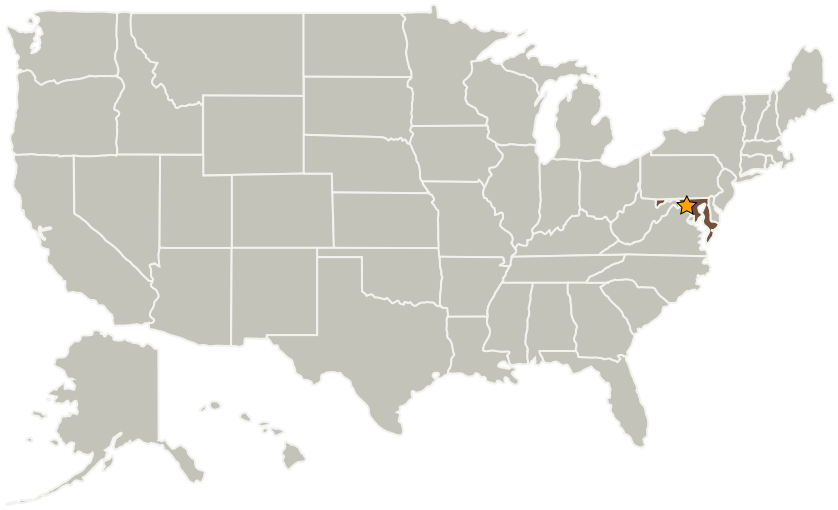
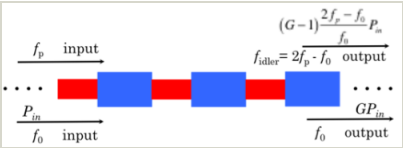
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Images



Parametric Amplifiers for Readout of Low-Temperature Detectors Project
Parametric Amplifier Sketch
(https://techport.nasa.gov/image/16629)

Organizational Responsibility

Responsible Mission Directorate:
Mission Support Directorate (MSD)

Lead Center / Facility:
Goddard Space Flight Center (GSFC)

Responsible Program:
Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:
Peter M Hughes

Project Manager:
Terence A Doiron

Principal Investigator:
Thomas R Stevenson

Co-Investigators:
Negar Ehsan
Megan E Eckart
Ari D Brown

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Links

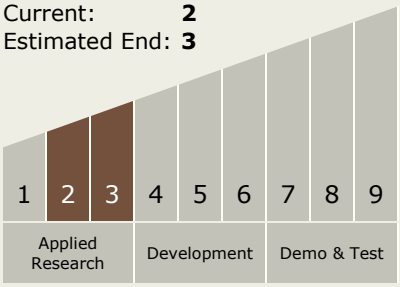
GSC-17504-1
(no url provided)

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.2 Electronics